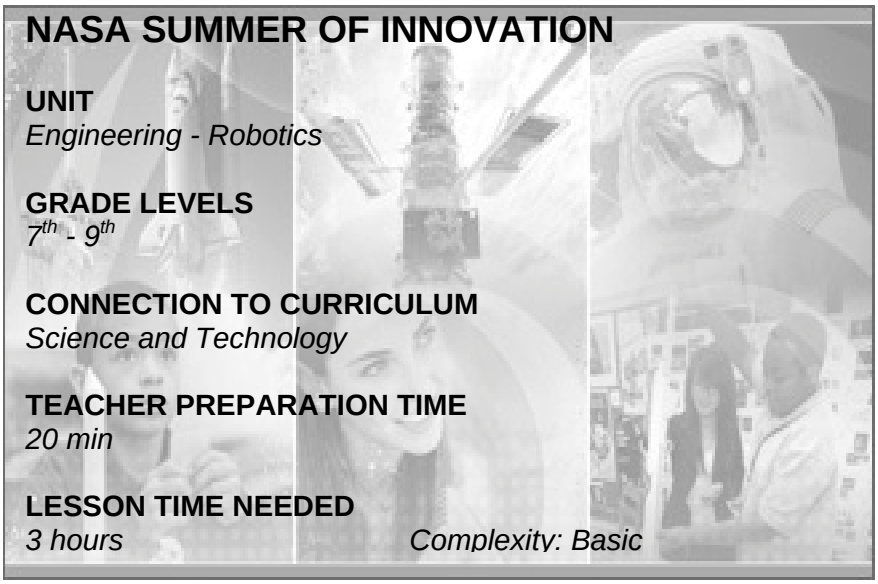
Robotics – Hands Down!

LESSON DESCRIPTION
This lesson includes a series of activities that are based on Robotics applications.

OBJECTIVES
Students will:

- Explain how the end effectors for the robotic arms used on the Space Shuttle and the International Space Station work
- Design and construct a grapple fixture that will enable the end effector to pick up an object
- Describe how artificial intelligence allows robots to behave more like humans
- Provide examples of real world applications of robotics



NASA SUMMER OF INNOVATION

UNIT
Engineering - Robotics

GRADE LEVELS
7^{th} - 9^{th}

CONNECTION TO CURRICULUM
Science and Technology

TEACHER PREPARATION TIME
20 min

LESSON TIME NEEDED
3 hours *Complexity: Basic*

NATIONAL STANDARDS
National Science Education Standards (NSTA)
Science as Inquiry

- Understanding of scientific concepts
- An appreciation of 'how we know' what we know in science
- Understanding of the nature of science
- Skills necessary to become independent inquirers about the natural world
- The dispositions to use the skills, abilities, and attitudes associated with science

Science and Technology Standards

- Abilities of technological design
- Understanding about science and technology

Science in Personal and Social Perspectives

- Personal health
- Risks and benefits
- Science and technology in society

History and Nature of Science

- Science as a human endeavor
- Nature of scientific knowledge
- Historical perspectives

ISTE NETS and Performance Indicators for Students (ISTE)
Creativity and Innovation

- Apply existing knowledge to generate new ideas, products, or processes
- Use models and simulations to explore complex systems and issues
- Identify trends and forecast possibilities

Communication and Collaboration

- Interact, collaborate, and publish with peers, experts, or others employing a variety of digital environments and media
- Communicate information and ideas effectively to multiple audiences using a variety of media and formats
- Develop cultural understanding and global awareness by engaging with learners of other cultures
- Contribute to project teams to produce original works or solve problems

Critical Thinking, Problem Solving, and Decision Making

- Identify and define authentic problems and significant questions for investigation
- Plan and manage activities to develop a solution or complete a project
- Collect and analyze data to identify solutions and/or make informed decisions
- Use multiple processes and diverse perspectives to explore alternative solutions

MANAGEMENT

Build an "End Effector" prior to class. Model for students the way to cut the Styrofoam cup. Demonstrate how to use either a serrated knife or scissors.

CONTENT RESEARCH

The following link provides additional resources for teachers and students and not necessarily a NASA resource but rather private industry, colleges, universities and organization that have taken an interest in one form or another in robotics, robotics competition, teaching, and design.
Please review content from the following resource:
http://robotics.nasa.gov/edu/6-8.php

Shuttle and Station Robotic Arm

Today, new exploration strategies are at work. The goal is no longer humans or robots. It is humans and robots working together. Each brings important complimentary capabilities to the exploration of space. On the Space Shuttle the 15-meter-long arm is mounted in the orbiter's **cargo bay**. It has seven **degrees of freedom** (DOF). The gripping device is called an **end effector**. That means it is located at the end of the arm and it has an effect (such as grasping) on objects within its reach.

Artificial Intelligence

Today's Robots have multiple **sensors** and are able to make their own decisions based on given information. Robots come in all shapes and sizes. **Artificial intelligence** allows robots to behave more like human beings and to act independently in a changing environment.

LESSON ACTIVITIES

End Effector

Students will learn how the end effectors works in the robotic arms used on board the Space Shuttle and the International Space Station. Students will design and construct a grapple fixture that will enable the end effector to pick up object.
http://virtualastronaut.tietronix.com/teacherportal/pdfs/humans.and.robotics.pdf

I Want to Hold Your Hand
To construct a robotic, human-like hand and demonstrate how grasping occurs.
http://www.nasa.gov/audience/foreducators/topnav/materials/listbytype/I_Want_to_Hold_Your_Hand.html

ADDITIONAL RESOURCES

Station Robotic Arm
Canada contributed an essential component of the International Space Station, the Mobile Servicing System. This robotic system plays a key role in space station assembly and maintenance: moving equipment and supplies around the station, supporting astronauts working in space, and servicing instruments and other payloads attached to the space station. Astronauts receive robotics training to enable them to perform these functions with the arm. http://www.nasa.gov/mission_pages/station/structure/elements/mss.html

Robonaut 2, the latest generation of the Robonaut astronaut helpers, launched to the space station aboard space shuttle Discovery on the STS-133 mission in 2011. It is the first humanoid robot in space, and although its primary job for now is teaching engineers how dexterous robots behave in space, the hope is that through upgrades and advancements, it could one day venture outside the station to help spacewalkers make repairs or additions to the station or perform scientific work.
http://www.nasa.gov/mission_pages/station/main/robonaut.html

Mars Science Laboratory:
Mars Science Laboratory is an unmanned robotic rover designed to land on Mars and assess whether Mars ever was, or is still today, an environment able to support microbial life -- to determine the planet's habitability. The rover, named Curiosity, is about the size of a small sport-utility vehicle. It will carry an advanced suite of instruments to study Martian terrain and soil.
http://sse.jpl.nasa.gov/missions/profile.cfm?MCode=MarsSciLab

Curiosity Robot cam:
Curiosity Cam takes you inside the clean room at NASA's Jet Propulsion Laboratory in Pasadena, California, so you can watch the next Mars rover being built. The camera may be turned off periodically for maintenance. The rover may occasionally be out of view as it is moved around the clean room. When Curiosity Cam is off air, you will see a slideshow of Mars and rover images.
http://www.nasa.gov/mission_pages/msl/building_curiosity.html.

MATERIALS
- Narrow rubber bands
- Drinking straws
- Cardboard
- Scissors
- Nylon cord
- Centimeter ruler
- Pencils
- Drawing compass
- Tape
- Glue
- Markers
- Crayons
- Color pencils
- Pen
- Styrofoam coffee cups (2 each) 6 oz
- String - 12-cm pieces (1 each)
- Cellophane tape
- Plastic picnic knives (serrated)

NASA Robotics:
Find out more how NASA plans to create a human, technical, and programmatic resource of robotics capabilities to enable the implementation of future robotic space exploration missions.
http://robotics.nasa.gov/

eClips:

Real World: Robotic Arm; Real World: TriATHLETE - The Engineering Design Process in Action; NASA 360 Mind Body Connection

http://www.nasa.gov/audience/foreducators/nasaeclips/search.html?terms=robotics

DISCUSSION QUESTIONS

- Make a Venn diagram to compare your hand to the robotic hand you made. *If it the humanoid Robonaut then the grasp is similar to humans, but if it is with the Shuttle or Station end effector then grasping is different*
- Write why you think some things cannot be picked up with your robotic hand. *Not enough strength, with end effector the cup must fit over the object otherwise it won't pick it up.*
- What items can you pick up with your robotic hand? *Simple, light weight items; like empty soda bottles, erasers, or pencils.*
- What would happen if you added more fingers? *You would have a better grasp but it may be harder to control.*
- What would happen if you added a thumb? *You will have two point of opposition for better grasping if controlled correctly.*

ASSESSMENT ACTIVITIES

Review the tables or charts created by your students. Pay special attention to the ideas students have for improving their grapple fixtures.

ENRICHMENT

- Students can enter First LEGO Robotics Competitions http://robotics.arc.nasa.gov/events/2011_sponsorship.php
- NASA Robotics: http://robotics.nasa.gov/students/sumo.php
- Robotics Summer Camps: http://robotics.nasa.gov/students/summer_camps.php
- NASA-KSC Luna-Botics : http://www.nasa.gov/offices/education/centers/kennedy/technology/lunabotics.html